Less Bang For Your Buck Part II

Richard VanCleave
Engineer of Road Plans
Division of Design, IDOH

INTRODUCTION

Last year the new Policy on Geometric Design of Highways and Streets - 1984, better known as the Green Book was adopted as the new highway guide for the design of highways by AASHTO. The FHWA basically decreed that the new Green Book would be the authority to be used as a guide in the design of new and major reconstruction projects; however, a grace period was provided for projects that were currently under design or that were already designed. This grace period extended for one year until May 15, 1986. Any project let after this date would be expected to adhere to the new Green Book guidelines irrespective of when the projects were designed, unless an exception to these guidelines had been granted on an item by item basis.

Although the grace period has provided us with some transition time to incorporate the new design guidelines and criteria into our plans, we are still experiencing great difficulties in completing plan development and letting projects before the May date. Obviously projects requiring the acquisition of right-of-way can only be accelerated by some minimal degree and cannot meet the May deadline.

Projects where the design has been completed within the last two to three years for the most part do not meet the new Green Book guidelines. If right-of-way has been purchased, any additional right-of-way acquisition necessitated by plan modifications to meet the new guidelines will require reopening negotiations with some property owners, involving some new owners in the land acquisition process as well as causing greater environmental impacts and rekindling animosities that may have previously exited, etc. Although some benefits in travel efficiency or safety may be realized from the incorporation of the new standards into the design of a project the increased effects, and possibly, the greater adverse impacts created by the seemingly ever-changing design produces potentially serious negative perceptions by the public, especially the affected public, regarding the state's creditability. In other words, the affected public does not always like the effects that a project may have upon them, but once acclimated to these effects, they do not want to be introduced

to additional changes which may create even more adverse effects upon their property, personal activities or businesses on a continuing basis.

GREEN BOOK DESIGN CHANGES

Several items mentioned in the new Green Book which vary from previous criteria, guidelines or concepts which we have followed or adhered to in developing highway plans in the past have introduced new design standards or considerations which have increased the complexity of projects.

The principle changes which have created the most difficulties, especially in already designed plans, are as follows:

1. **Vertical Alignments —**
   New K values for both crest and sag vertical curves have increased because of the adoption of a new height of eye for a vehicle driver. This tends to lengthen vertical curves, which creates a problem on previously designed projects because of limited availability of right-of-way, etc.; however, on new design the problems are minimal as long as we are able to use K values in the lower to middle portion of the range of acceptable values. When we are required to use K values in the upper or more desirable half of the range, the vertical curves become very long which is especially critical on overpasses where bridges are involved and certain bridge clearances must be provided. The primary problem results from the increased impact on property owners. Almost all older designs do not meet current criteria on county roads, although the mainline designs will normally meet minimal new requirements.

2. **Functional Classification of Roads and Streets —**
   In the past, design criteria was based upon the traffic volume or a certain reasonable speed, now, design is based upon functional classification of the road. Where past practice dictated the use of a 50 mph design speed for a local county road such as those which are separated over the mainline, present Green Book buidelines may require as much as a 70 mph design speed for the same road because the functional classification is an arterial road. Many times neither the projected traffic counts nor the alignment or condition of the present road supports this high of a design standard. Short stretches of road improvement provided by our design which is predicated upon the current functional classification of the road usually extends the limits of the improvement section and may contribute to potential problems in the future because once a driver enters the improved section of roadway he tends to expect the im-

proved section to continue for several miles rather than for several hundred feet.

3. **Interchange Geometrics —**
   Minimum acceleration and deceleration lengths have been included in tables in the new Green Book. In general, the minimum deceleration lengths are easily met when the MV-4 standard exit geometrics are provided in the plans; however, the minimum acceleration lengths sometimes poses problems, especially when a loop-type ramp is involved. Loop ramps located adjacent to each other in cloverleaf-type interchanges do not have to adhere to the acceleration-deceleration length criteria; however, it is recommended in the Green Book to provide a distance of 1000 ft. between ramp noses which tends to "stretch out" cloverleaf interchanges making them practically infeasible to construct because of their size, unless they are located in an undeveloped area where right-of-way is relatively cheap. Loop-type ramps in par-clo interchanges require nearly one-half mile long acceleration lanes to meet the new criteria because of the relatively slow speeds attainable on the loops.

   Standard MV-4 acceleration lanes usually comply favorably with the new design criteria on primary and interstate projects.

4. **Guard Rail Offsets —**
   The Green Book calls for offsetting the face of guard rail 2 ft. from the outer edge of the usable shoulder with an additional area of graded shoulder to be provided for lateral post support or deflection of rail beyond the back of the post. Discussions with the local FHWA personnel have established mutually acceptable standards calling for an offset of 1 ft. from the outer edge of the usable shoulder to the face of rail and a graded shoulder width of 2 ft. behind the guard rail post for lateral support. Adherence to this new criteria require shoulders to be constructed 3 ft. 3 in. wider than previously constructed where guard rail must be provided. Although the new guard rail shoulder construction requirements should pose only minimal, if any, problems in rural areas, where right-of-way is very tight in urban areas or especially on already designed projects where right-of-way has been purchased, significant problems may arise. If B.C.T. guard rail end treatment is to be provided, shoulders may require widening as much as 7 ft. 3 in. which further compounds the problem.

5. **Green Book Guidelines on Spot Improvements —**
   On many spot improvements such as small structure replacements, sight distance corrections or intersection improvements, strict adherence to the new AASHTO guidelines result in improving

short, some very short, sections of roadway. Some improvement sections may be only 50 to 100 ft. long with full width shoulders and pavement which is much better than existing conditions on the remainder of the road which may stretch for miles. Such an expenditure of funds for these short sections, which do not contribute to the safety of travel on that highway in general, does not seem to be cost-effective, especially where no future improvements for that particular route are scheduled in the foreseeable future.

Some examples of the effects of the application of the new Green Book guidelines for new or previously designed projects are as follows:

1. The 1984 AASHTO "A Policy on Geometric Design of Highways and Streets" has provided a challenge to the highway engineer. Learning the new standards in itself is a paper chase and quite time consuming. This, however, is not the true challenge. The true challenge is to arrive at an alternate solution that satisfies the new policies yet is in the realm of financial feasibility. The tought standards and even tougher enforcement of the standards have inflated the anticipated construction costs of many projects. The following example is perhaps not typical, but clearly illustrates this challenge.

   US 50 east of Bedford has been the subject of a highway improvement study. The initial study was completed in March of 1984, prior to the release of the new standards. The proposed facility would have consisted of just adding a truck lane or, if geometrics were obviously substandard, providing new horizontal and vertical alignment in accordance with the Blue Book. The remainder of the design standards were as follows:

Design Year Traffic (DHV)	650
Design Speed, mph	70
No. of Lanes, Width (ft)	2 @ 12 ft
Design Basis	Two-Way Road
Shoulder Width (ft) stabilized	10
Curvature, Max. Degree	3½
Gradient, Max. Percent	4

   The provisions of the study called for addition of "truck passing lanes" on steep grades. This consisted of the addition of a single lane for traffic proceeding uphill. Under the proposal, a minimum of 80% passing opportunity was provided with the additional lane as opposed to wide spread grade reduction. The proposal allowed a minimum of related earthwork and land acquisition. It also provided the most pavement that could be salvaged. These facts contributed to a low cost estimate. A 4.55-mi segment was anticipated

to cost approximately $2,073,000. This proposal was abandoned since its implementation could not be finished prior to the release of the new standards.

The next alternate examined was a full compliance with the 1984 standards. It was assumed that provided a four-lane facility would be less expensive than a two-lane facility. This was assumed true because of the rolling terrain. With the four-lane facility, passing opportunity would not be a function of passing sight distance. This would allow fewer corrections to the vertical alignment. Later this assumption was verified as correct. The design standards were as follows:

Design Year Traffic (DHV)	650
Design Speed, mph	60
No. of Lanes, Width (ft)	4 @ 12 ft
Design Basis	Two-Way Road
Shoulder Width (ft) Stabilized	10
Curvature, Max. Degree	4°-45′
Gradient, Max. Percent	4

As would be expected, construction of a four-lane facility would involve a substantial amount of earthwork. Since the facility was originally constructed using different standards, the existing alignment is far from adequate. Major corrections to the vertical alignment are needed. This in turn disallowed pavement to be salvaged. Basically, the entire facility would have to be replaced. Existing right-of-way was about all that could be saved. The estimated cost was $5,162,000 for the same length of roadway.

This figure was clearly out of reach. With average design hour volume at 650, a four-lane facility was twice as much as needed.

The third attempt for a solution was made. This time, a 3R approach was tried. 3R stands for Restoring, Resurfacing and Rehabilitation. It complies to AASHTO's median standards. These standards are as follows:

Design Year Traffic (DHV)	650
Design Speed, mph	50-60
No. of Lanes, Width (ft)	2 @ 12 ft*
Shoulder Width (ft) Stabilized	8 ft
Curvature, Max. Degree	7° 30′ - 4° 45′ (Existing horizontal alignment would be maintained)
Gradient, Max. Percent	7%-6%

*Truck climbing lane where needed

Under this option, horizontal alignment was not corrected. Substantial vertical alignment correction was necessary. Stopping

sight distance was provided in all locations. Where necessary, grade reductions were used to accomplish this goal. The 3R solution required substantially less earthwork than full AASHTO. It also made it possible to salvage approximately 50% of the existing pavement. The anticipated cost of construction was set at $2,823,000 for the same 4.55 mi segment. Unfortunately, this proposal has received a great deal of opposition from the Federal Highway Administration. The prescribed improvements were deemed beyond the scope of intended improvements for 3R corrections.

A fourth and final study was conducted in an effort to illustrate the merits of 3R in comparison to full adherence to AASHTO. The last set of design criteria examined was as follows:

Design Year Traffic (DHV)	650
Design Speed, mph	60
No. of Lanes, Width (ft)	2 @ 12 ft
Design Basis	Two-Way Road
Shoulder Width (ft) Stabilized	10 ft
Curvature, Max. Degree	4°-45′
Gradient, Max. Percent	4

This alternate, as shown, would provide a two-lane facility with 80% passing opportunity. Upon inspection of this alternate, it quickly became apparent that the earthwork and land acquisition required would be prohibitive. Preliminary calculation showed that approximately 57,000 cu yd of cut would be needed in addition to 1,400,000 cu yd of fill. The cost estimate for the proposal was set at $8,334,000.

2. The May 15, 1986, deadline for letting projects that did not meet Green Book standards has produced a number of problems for our Bridge Design Department. Some bridges that had received design approval from the FHWA with the design nearly complete had to be redesigned to meet the new guidelines. The May deadline was imposed on relatively short notice which did not allow adequate time to let the bridges before May 15th. A better solution would have been to require any project which had not received design approval by the May 15th deadline adhere to the new guidelines.

   The lengthening of many of the interchange acceleration and deceleration lanes has necessitated the widening of adjacent bridges which has doubled or tripled the cost of a normal bridge rehabilitation project.

   Many local public assistance projects have been unduly delayed in order to meet the new guidelines or to request approval of ex-

ceptions to the guidelines. Costs are likely to increase by 25% ore more.

3. The plans for the Fort Wayne Southeast Bypass projects which have been under design for several years have been signed; however, even though the projects are scheduled for late 1986 or early 1987 lettings they may have to be revised to meet the new guidelines. Almost all crossroad overpasses must be redesigned to meet the vertical curve criteria including both sag and crest vertical curves which were originally designed for a 50 mph design speed and did meet the applicable design criteria prior to the advent of the Green Book. However, the current functional classification of these roads requires a higher design speed and adherence to the new higher level criteria. Eight crossroads must be revised and one mainline vertical curve must be revised if the new guidelines prevail. If any interchanges have to be redesigned to meet the new guidelines and "spread out" more, then, the original design concepts wherein geometrics were to be provided to minimize the right-of-way requirements and the subsequent impacts upon the adjacent properties would be violated and what trust the local residents have in the Indiana Department of Highways will be somewhat diminished. As in the case of the bridges, sufficient time was not available to make the necessary changes and considerable redesign is necessary. The current design was approved on November 8, 1983.
4. The Keystone Avenue/North Leg Interstate 465 interchange modification requires lowering the existing Keystone Avenue pavement in order to meet 16 ft 6 in. desirable vertical clearance requirements under the Interstate 465 bridges rather than the minimum clearance of 14 ft 6 in., which approximates the existing clearance. Obviously, lowering the grade 2 ft or more will complicate maintenance of traffic problems and greatly reduce traffic flows through an already congested area.
5. Weaving distances requirements as well as deceleration-acceleration lane length requirements will result in the almost complete reconstruction of the US 31/Interstate 265 interchange north of Jeffersonville when I-265 is extended eastward. The interchange will occupy a vastly greater area, also, requiring markedly more right-of-way.
6. Some projects such as I-164 near Evansville may end up with some adjacent bridges, etc., built to two different guidelines because of stage construction which will span the May 15th deadline.